



Liquid Hydrogen Delivery

Strategic Directions for
Hydrogen Delivery Workshop
May 7-8, 2003
Crystal City, Virginia



Main Themes/Caveats

- Will be challenging (if not impossible) to meet the 2010 cost target with today's technology
- Without significant growth in product demand, progress will likely be slow even with incremental technology
- Group a little light on technical expertise, but feel captured main ideas required
 - Less “weeding” of ideas, but more divergent thinking

Targets/Objectives

- 2003 Status: \$1.11/kg
 - May be a bit lower than actual costs
 - Baseline needs to be revisited
- 2005 Target: \$1.01/kg
 - Technically (10% improvement) could be met, but unlikely demand drivers will be present to encourage meeting target
 - Likely no plant will be built in 2005
- 2010 Target: \$0.53/kg
 - Will require step-change advancement in technology
 - Even with great demand and larger plants, could only get halfway there with current technology



Priority Barriers

- Limitations of existing refrigeration technologies
- High capital costs of units coupled with need for market
- Lack incentives to prime sufficient hydrogen demand



R&D Needs

- Fundamental study on innovative liquefaction technologies
- Investigate innovative liquid hydrogen storage concepts
- Investigate potential for improved ortho—para conversion technologies (lower refrigeration requirement)
- Develop advanced alloys and manufacturing technologies for heat exchangers
- Develop integrated refrigeration and power generation systems
- Develop additives that could raise the liquefaction temperature and separate as liquid



R&D Activities

- Two parallel paths for activities
 - Incremental improvements
 - Diverse, step change concepts
- More complete evaluation/assessment of refrigeration technology
- Fundamental studies on properties and interactions
- Fund lab-testing of innovative liquefaction and storage concepts



“Take home” messages

- Liquid will have a role in delivering hydrogen for vehicles
- Dramatic improvements will be required in liquefaction technology
- Relatively mature field of study – government funding needed for incremental improvements
- Advancements to the goal will not be linear – government funding needed for development